

HERBIVOROUS INSECTS ASSOCIATED WITH THE PAPERBARK *MELALEUCA QUINQUENERVIA* AND ITS ALLIES: I. NOCTUOIDEA (LEPIDOPTERA)

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Abstract

Although *Melaleuca* spp. trees and shrubs are diverse, common, and widely distributed throughout Australia, there are few published records of insects associated with them. Since late 1986, surveys have been conducted in northern Queensland, south-eastern Queensland, and northern New South Wales to detect insects with potential for controlling *M. quinquenervia* in Florida, USA, where it has become a serious pest. Over 400 herbivorous insects have been found associated with this tree and its close allies in Australia. This paper presents our records, including brief descriptions of many larvae, for 22 species of Noctuoidea moths (1 Arctiidae, 9 Lymantriidae, 11 Noctuidae, and 1 Thaumetopoeidae) collected and reared on *M. quinquenervia* and five closely related species. Literature references, where available, to other host plants of each moth species are provided. Supplementary records are also presented for three additional Noctuoidea species which were only collected from these trees as adults or pupae.

Introduction

Australia's landscape is dominated by plants belonging to the family Myrtaceae. Within this very large family, Australian members of the genus *Melaleuca* are well represented, both in diversity - approximately 200 species - and geographic distribution - from the Northern Territory to Tasmania (Holliday 1989). While the insects associated with some Myrtaceae, especially *Eucalyptus* have been studied [see Ohmart & Edwards (1991) for an excellent review of the literature on *Eucalyptus* insects], those utilizing *Melaleuca* species are very poorly known. Froggatt (1923), in Australia's first compendium of forest insects, did not include any *Melaleuca* insects. Common (1990, Appendix B) lists 153 moth species which have been recorded from *Eucalyptus* in the field, 9 moth species whose field host was unknown, but which fed on *Eucalyptus* in the laboratory, and another 25 moth species which fed on dead *Eucalyptus* leaves. For *Melaleuca*, he lists only 12 moth species.

Melaleuca quinquenervia (Cav.) S.T. Blake, is one of 10 closely-related, broad-leaved paperbarks placed in the *Melaleuca leucadendra* (L.) L. complex (Blake 1968). Since its introduction into Florida, USA at the beginning of the century, *M. quinquenervia* has achieved notoriety as a serious exotic pest (Balciunas 1990). It is currently thought to infest approximately half a million acres (Cost & Craver 1981) in southern Florida. In the absence of natural enemies and competition, it has aggressively displaced native plant communities, resulting in dense monocultures that threaten the stability of the ecosystem (Langeland 1990). Physical and mechanical removal of this pest, combined with application of herbicides, have proven too expensive and time consuming for large scale management.

In 1977, during a preliminary, six week survey in Australia and New Caledonia for potential biological control agents for *M. quinquenervia*, Habeck (1981) found more than 40 species of insects. In 1986, the senior author received a modest grant to further investigate the potential of Australian insects for biological control of *M. quinquenervia*. By the end of 1988, more than 150 insect species attacking *Melaleuca* spp. had been found in Queensland and New South Wales, and (very importantly) the potential conflicts of interest in the USA, primarily with honey producers, were close to resolution (Balciunas & Center 1991). Consequently, funding was increased, and the small, temporary, University of Florida aquatic weed laboratory in Townsville converted into the much larger Australian Biological Control Laboratory (ABCL), one of the overseas laboratories of the United States Department of Agriculture (USDA). At present, the primary mission of the ABCL is to conduct research for detecting and evaluating biological control agents for *M. quinquenervia*. Further surveys by the ABCL, have considerably extended the *Melaleuca* insect list, with over 400 species of natural enemies having been recorded by the end of 1991 (Balciunas et al. in press).

This paper, the first in a series reporting on the *Melaleuca* insects detected during these surveys, covers the moth superfamily Noctuoidea. The taxonomic status of Australian Lepidoptera has recently been revised (Common 1990; Nielsen & Common 1991) and this superfamily has undergone some significant changes. Among the more pertinent to this paper are the merging of the four families of Notodontidae (Common 1970) into the Noctuoidea, and the demotion of the family Nolidae, to subfamily status under the Noctuidae. This has resulted in the Noctuoidea now containing 9 families, 7 of which are represented in Australia.

Methods

The majority of the moth larvae were collected in our quantitative samples, which, at the end of 1991, totalled 834 samples. Each quantitative sample consisted of approx. 1 kg of field collected plant material. In the laboratory, the plant portions (twigs, leaves, fruit and flowers) were separated and weighed, and all insect herbivores on each portion counted. Adults were preserved, while immatures were reared on the appropriate plant portion of the host from which they were collected. Fruit and flowers were kept in individual zip-lock bags, and examined over the following 1-2 months for additional insects which emerged. These quantitative collections were supplemented by direct collections of insects from the field and our shadehouse cultures.

All of our Noctuoidea moths were collected and reared on *M. quinquenervia* (539 quantitative collections) or five of its close relatives in the *M. leucadendra* complex: *M. leucadendra* (173 collections), *M. dealbata* S.T. Blake (63), *M. viridiflora* Sol. ex Gaertn. (21), *M. new* sp. A (24), *M. cajuputi* Powell (5). *Melaleuca new* sp. A is a distinctive, linear-leaved species,

frequently encountered along the streams west of Townsville, which according to Bryan Barlow (pers. comm.), will be considered as a new species in his forthcoming monograph on *Melaleuca*. For three of these moths, we also included records of rearings from more distantly related Myrtaceae; *M. diosmatifolia* Dum.Cours; *Callistemon viminalis* G. Don ex Loudon and *Eucalyptus ptychocarpa* F. Muell.

Our collecting was concentrated in two main regions along the east coast of Australia. In northern Queensland (NQ), our regularly sampled sites ranged from the Daintree River, north of Cairns, to Townsville. The NQ sites referred to in the text are: **AIMS Road** (19°16.9'S 147°0.9'E), 21 km E of Townsville; **Alice River** (19°27.5'S 147°28.9'E), 24 km WSW Townsville; **Apex Park** (19°21.7'S 146°43.9'E), Rassmussen, Townsville; **Cardwell Swamp** (18°16.6'S 146°2.2'E), 1.5 km SE of Cardwell; **Centenary Park** (16°54'S 145°44.8'E), Cairns; **Corduroy Creek** (18°3.9'S 145°54.6'E), 14.5 km S of Tully; **Edmund Kennedy National Park** (18°14.6'S 146°0.1'E), 4 km NW of Cardwell; **Eubenangee Swamp** (17°24.6'S 145°58.7'E), 9 km SE of Babinda, nr Innisfail; **Feluga Site 2** (17°54.9'S 146°0.6'E) and **Feluga Site 3** (17°52.9'S 146°E), 9.5 and 13 km NE of Tully; **Five Mile Creek** (18°19.7'S 146°2.9'E), 7 km SSE of Cardwell; **Forrest Beach West** (18°42.6'S 146°17.4'E), 16 km SE of Ingham; **Gordonvale** (17°5.5'S 145°46.4'E), 18.7 km S of Cairns; **Hubinger Road** (18°13.3'S 145°58.7'E), 7 km NW of Cardwell; **James Cook University** (19°19.9'S 146°45.5'E), Townsville; **Keelbottom Creek** (19°29.3'S 146°20.1'E), 58 km WSW of Townsville; **Murrigal** (18°04.8'S 145°54.4'E), 16 km S of Tully; **Nathan Plaza** (19°18'S 146°45.6'E), Townsville; **Pease Street Park** (16°54.3'S 145°44.4'E), Cairns; **Rockingham Road** (18°0.2'S 145°57.6'E), 9 km SSE of Tully; **Rowes Bay** (19°14.6'S 146°47.5'E), Townsville; **Three Mile Creek** (19°12.9'S 146°46.5'E), Townsville.

Our second major collecting region stretched from Cooloom in south-eastern Queensland (SQ) to Grafton in northern New South Wales (NSW). The SQ sites referred to in the text are: **Aspley** (27°21.5'S 152°59.7'E), Brisbane; **Bracken Ridge** (27°19.2'S 153°2.8'E), Brisbane; **Browns Plains** (27°39.5'S 153°0.2'E), **Logan City**, 21 km S of Brisbane City Centre; **Burpengary** (27°9.5'S 152°58.4'E), 34 km N of Brisbane City Centre; **Chelmer** (27°31.0'S 152°58.3'E), Brisbane; **Cooloom** (26°34.1'S 153°5.5'E), 10 km N of Maroochydore; **Corinda** (27°32.8'S 152°58.6'E), Brisbane; **Doolandella** (27°37.3'S 152°59.0'E), Brisbane; **Fitzgibbon** (27°20.1'S 153°1.8'E), Brisbane; **Gailes** (27°35.9'S 152°55.1'E), Brisbane; **Gumdale** (23°30.3'S 153°11.5'E) Brisbane; **Long Pocket CSIRO Laboratories** (27°30.7'S 152°59.8'E), Brisbane; **Palm Beach** (28°6.7'S 153°27.3'E), Gold Coast; **The Pines** (28°0.7'S 153°27.8'E), Gold Coast; **Sherwood** (27°31.8'S 152°58.8'E), Brisbane.

We also present several records from NSW: **Junction Hill** (29°29.0'S 152°55.5'E), 3 km NNW of Grafton; **Pottsville** (28°22.8'S 153°34.4'E), 23

km S of Coolangatta; and one from Darwin; **Berrimah Conservation Commission Nursery** (12°26.8'S 130°55.9'E).

Results

Moth Records for Larvae Reared on Hosts

Unless otherwise noted, all specimens were collected and reared to the adult stage on *M. quinquenervia*.

Family Arctiidae

Arctiidae, undet. sp.

Cream coloured larva, 20 mm long, with longitudinal, black streaks and 3-8 mm bristles. **Edmund Kennedy National Park**: Adult emerged from larva collected 9.vii.90 and reared on leaves.

Family Lymantriidae

Euproctis sp.

Larva has tufted setae and feeds on foliage. The larvae of several of the 21 Australian species of *Euproctis* have urticating hairs which can cause severe rashes in some people who come in contact with them (Common 1990).

Corinda: Larva collected 2.ii.88, pupated 4.ii.88, adult emerged 15.ii.88.

Olene mendosa Hübner (Brown Tufted Caterpillar).

The larva is brown, hairy with grey tufts. Jones and Elliot (1986) list this moth as a minor pest of *Macadamia* and *Grevillea* (both Proteaceae). **James Cook University**: Feeding on foliage of a potted *M. dealbata* tree at the ABCL shadehouse, pupa collected 17.viii.89, adult emerged 28.viii.89.

Olene sp. B

Three Mile Creek: *M. leucadendra*. Larva collected 25.vii.90, fed on flowers, pupated 10.ix.90, adult emerged 23.ix.90.

Porthesia spp.

Probably 6 species, none of which can yet be reliably determined. Larvae have long setae over the body and have four thick conspicuous brushes (vericules) of light brown setae protruding dorsally from the anterior segments. Larvae fed primarily on flowers, but were also reared on leaves which were webbed loosely together and grazed by the larva. Pupation takes place in a cocoon of silk-bound setae.

Porthesia sp. B (white wings and body)

Eubenangee Swamp: Pupa collected 6.v.88, adult emerged 12.v.88. **Pease Street Park**: Larva collected 29.vii.88, reared on flowers, adult emerged 15.viii.88.

Porthesia sp. C (white hindwings, yellow forewings and abdomen tip)

Pease Street Park: Larvae collected 9.vii.90, reared on flowers, 3 adults

emerged 9.viii.90.

Porthesia sp. D (yellow wings and body)

Keelbottom Creek: *M. leucadendra*. Larvae collected 13.viii.90, reared on flowers, pupated 13.ix.90, 1 adult emerged 25.ix.90. **Rowes Bay:** *M. leucadendra*. Larvae collected 23.viii.90, reared on flowers, 1 adult emerged 23.ix.90, 4 adults emerged 2.x.90.

Porthesia sp. E (white wings and body, yellow abdomen tip)

Apex Park: *M. leucadendra*. Larva collected 13.viii.90, fed on leaves, pupated 31.viii.90 between the bound leaves, adult emerged 14.ix.90.

Forrest Beach West: Larvae collected 14.viii.90, reared on leaves, pupated 8 & 12.ix.90, 2 adults emerged 21 & 25.ix.90. **James Cook University:** *M. viridiflora*. Larva collected 14.vi.90, reared on flowers, adult emerged 26.vii.90. *C. viminalis*. Larva collected 28.viii.89, reared on leaves, pupated 1.ix.89, adult emerged 14.ix.89. *C. viminalis*. Adult collected 22.v.90.

Pease Street Park: Larva collected 9.vii.90, reared on flowers, adult emerged 30.viii.90.

Porthesia sp. F (yellow wings, red thorax and abdomen)

Keelbottom Creek: *M. leucadendra*. Larvae collected 13.viii.90, reared on flowers, pupated 12.ix.90, 2 adults emerged 23 & 28.ix.90.

Porthesia sp. G (white wings and thorax, yellow abdomen)

Rowes Bay: *M. leucadendra*. Adult emerged from flower-feeding larva collected 21.vi.90 and pupated 15.viii.90. **James Cook University:** *E. ptychocarpa*. Larva collected 8.ix.89, reared on leaves, adult emerged 28.ix.89.

Family Noctuidae

Agrotis sp. (Common Cutworms)

Several species of this genus are polyphagous across a broad range of vegetable and field crops. Swaine and Ironside (1983) include tomatoes (Solanaceae: *Lycopersicon*), maize (Poaceae: *Zea mays*) and sunflower in their list of larval food-plants. **Long Pocket CSIRO:** Larva collected on 23.ix.88, while feeding on a seedling of *M. quinquenervia* in glasshouse, reared on foliage, pupated 3.xi.88, adult emerged 22.xi.88.

Careades (previously *Aiteta*) *plana* Warren.

The larva of *C. plana* has a unique appearance, with a greatly swollen, bulb-like structure on the dorsum of the thorax. Pupation takes place in a white, boat-shaped cocoon spun on the surface of the leaf. The larvae, while often solitary (usually only one or two are collected at one time), are voracious foliage feeders. *C. plana* has only been collected from *M. quinquenervia* and is probably specific to it, and is worthy of further investigation as a potential biological control agent. Two parasitoid species, an unidentified Braconidae

(Hymenoptera) and an unidentified Diptera, have been reared from *C. plana* larvae. **Centenary Park:** Larva collected 4.viii.87, died 14.ix.87. **Corduroy Creek:** Larva collected 28.v.91, pupated 9.vi.91, adult emerged 25.vi.91, adult died 4.vii.91. **Edmund Kennedy National Park:** Larva collected 30.v.88 and later died. **Eubenangee Swamp:** Larva collected 4.v.87, pupated 30.v.87, adult emerged 12.vi.87. 4 larvae collected 13.x.87 and all later died. Larva collected 15.vi.88, parasitized by a unknown dipteran. Larva collected 26.ix.88 and later died. Larva collected 10.vii.89, died 19.vii.89. Larva collected 7.viii.89, pupated 17.viii.89, adult emerged 1.ix.89. **Feluga Site 3:** 2 larvae collected 11.x.89 and both later died. Larva collected 17.i.90 and later died. Larva collected 9.vii.90, pupated 31.vii.90, adult emerged 13.viii.90. Larva collected 23.iv.91, pupated 18.v.91, adult emerged 1.vi.91, adult died 11.vi.91. **Forrest Beach West:** Larva collected 7.iv.87 and later died. Larva collected 20.vii.87, pupated 28.vii.87, adult emerged 11.viii.87. Larva collected 5.ix.88 and later died. Larva collected 13.iii.89, died 5.iv.89. 2 larvae collected 13.viii.89, pupated 18-21.viii.89, 2 adults emerged 4.ix.89. 2 larvae collected 4.vi.90 and later died. Larva collected 14.viii.90 and preserved. Larva and pupa collected 17.ix.90, adult emerged from puparium 11.x.90, larva later died. Larva collected 2.xii.91 and later died. **Murrigal:** Larva collected 22.vii.91 and later died. **Pease Street Park:** Larva collected 14.iv.87, pupated 21.iv.87, adult emerged 5.v.87. Larva collected 14.iii.90, pupated 4.iv.90 but failed to emerge. Larva collected 12.xi.90 and later died. Larva and pupa collected 6.v.91, adult emerged from puparium 15.v.91 and appeared to feed on flower nectar, adult died 4.vi.91, larva pupated 3.vi.91, adult emerged 17.vi.91. Larva collected 16.vi.91, 20 Braconidae wasps emerged 10.vii.91 and spun a group of small white cocoons on a leaf, adult wasps emerged 15.vii.91.

Celama argentea (Lucas).

Edmund Kennedy National Park: Larva collected 20.vii.87, reared on foliage, pupated 6.viii.87, adult emerged 11.viii.87.

Characoma vallata (Meyrick).

The 9 mm larva of *C. vallata* is white or pale brown, with a dark brown head and pro-thoracic shield. The body is sparsely covered with translucent hairs, and more densely, with fine, reddish- brown speckles. It frequently feeds on *Melaleuca* flowers, on which it constructs a retreat composed of silk and floral portions. Occasionally, the larva tightly web leaves of the *M. quinquenervia* tips together, forming a retreat within which it consumes the inner leaves. Development is completed inside the retreat and the pupal case is protruded slightly when the adult emerges. The larvae were collected on *M. quinquenervia* in NSW, SQ and NQ, and also on *M. viridiflora* in NQ.

Northern Queensland records.

Centenary Park: Larva collected 6.v.91, reared in flowers, adult emerged 6.vi.91. **Corduroy Creek:** Tip-binding larva collected 12.iii.91, reared in

bound tip, pupated 1.iv.91, adult emerged 14.iv.91. **Edmund Kennedy National Park:** Tip-binding larva collected 6.v.88, reared in bound tip, adult emerged 30.v.88. Tip-binding larvae collected 12.vii.88, reared in bound tips, 2 adults emerged 5.viii.88 and 1 on 18.viii.88. **Five Mile Creek:** *M. viridiflora*. Adult reared from flower-feeding larva collected on 3.vii.87. **Forrest Beach West:** Larva collected 6.vi.90, reared in bound tip, adult emerged 31.viii.90. Larvae collected 14.viii.90, reared in bound tips, 3 adults emerged 4.ix.90. **Feluga Site 2:** Larvae collected 28.vii.88, reared in flowers, 5 adults emerged between 8.viii.88 and 15.viii.88. **Hubinger Road:** 6 larvae collected 12.iii.91, reared in bound tips, pupated 27.iii.91, 5 adults emerged between 1.iv.91 and 4.iv.91. **James Cook University:** *M. viridiflora*. Larva collected 28.iii.88, reared in flowers, pupated 14.iv.88, adult emerged 25.iv.88. **Nathan Plaza:** Larvae collected 5.iii.91, reared in bound tips, 1 adult emerged 27.iii.91. **Rockingham Road:** *M. viridiflora*. Larvae collected 12.iii.91, reared in flowers, pupated 14- 18.iii.91, 7 adults emerged between 28.iii.91 and 2.iv.91.

South-eastern Queensland and northern New South Wales records.

Aspley: 2 larvae collected 29.ii.88, one preserved, other reared in flowers, pupated 4.iii.88, adult emerged 14.iii.88. **Browns Plains:** Larva collected 8.iii.88, died 14.iii.88. **Burpengary:** 2 larvae collected 8.iii.89, reared in flowers, pupated 20.iii.89, adults emerged 28 and 30.iii.89. 4 pupae collected 8.iii.89, 4 adults emerged between 12 and 14.iii.89. **Chelmer:** Larva collected 21.i.88, reared in flowers, pupated 27.i.88, adult emerged 8.ii.88. **Coolum:** Larva collected 1.v.90, reared in flowers, pupated 13.v.90, adult emerged 23.v.90. Larva collected 11.ii.91, reared in flowers, pupated 22.ii.91, adult emerged 4.iii.91. **Doolandella:** Larva collected 8.iii.88, reared in flowers, pupated 25.iii.88, adult emerged 5.iv.88. **Gumdale:** Larva collected 26.vii.89, reared in bound tips, pupated 5.viii.89, emerged 21.viii.89. **Junction Hill:** Larva collected and preserved 17.i.89. **Sherwood:** 4 larvae collected, 1 preserved, 3 reared in flowers, 1 pupated 4.iii.88, adult emerged 14.iii.88, 1 parasitized by Braconidae (Hymenoptera). **The Pines:** Adult emerged from flower-feeding larva collected 10.iv.88 and pupated 19.iv.88.

Eublemma silicula (Swinhoe).

The specimens from Bracken Ridge were originally identified as *Eublemma compsoprepes* (Turner). However, in the forthcoming checklist of Australian Lepidoptera (the Noctuoidea portion prepared by E.D. Edwards), this will be a synonym of *E. silicula*, the same species which we have reared from our other sites. The larva feeds in flowers and flower buds of *M. quinquenervia* by tunnelling through the wall of the floral tube into the ovary, where it consumes all but the ovary wall. The larva binds a petal over the floral tube and shelters within, leaving the retreat to pupate in a small bullet shaped cocoon attached to the rachis of the inflorescence. Some larvae displayed a leaf-feeding habit, and attached their cocoons to leaf surfaces. **Alice River:**

M. new sp. A. Adult emerged from foliage-feeding larva collected 18.vii.88. **Bracken Ridge:** 2 adults collected 24.iii.87. **Centenary Park:** Larva collected 6.v.91, reared in flowers, adult emerged 11.vi.91. **Feluga Site 3:** Larva collected 16.vi.91, reared in flowers, pupated 26.vi.91, adult emerged 11.vii.91. **Gailes:** Larva collected 16.ii.88, reared in flowers, pupated 19.ii.88, adult emerged 1.iii.88. **Pease Street Park:** Larva collected 29.viii.90, reared in flowers, adult emerged late September 1990.

Homodes bracteigutta (Walker).

The larvae are delicate, pale-green loopers with anterior and posterior concentrations of clubbed setae. Common (1990) notes that these larvae closely resemble two green ants, *Oecophylla smaragdina* (Fabricius), joined end-to-end, among which the larvae freely mingle. He lists larval food-plants as the mistletoe, *Amyema conspicuum* (Loranthaceae), *Cupaniopsis anacardioides* (Sapindaceae) and mango (Anacardiaceae: *Mangifera indica*). **Edmund Kennedy National Park:** 3 larvae collected 11.vii.88, reared on foliage, 3 adults emerged 22- 31.vii.88.

Nanaguna breviscula Walker.

Common (1990) reports a record of these larvae on *Grevillea glauca* (Proteaceae). Robinson (1975) lists Fijian larval food-plants as *Desmodium umbellatum*, now known as *Dendrolobium umbellatum* (Fabaceae) and mango. **Feluga Site 2:** Larva collected 11.vii.88, reared in flowers, adult emerged 3.viii.88.

Ophiusa disjungens (Walker).

According to Common (1990), larval food-plants are not known in Australia, but this moth is widely distributed throughout the South Pacific, where it has been reported on *Eucalyptus* and other Myrtaceae. **AIMS Road:** *M. dealbata*. Adult emerged from a pupa collected on 11.ix.86. **Long Pocket CSIRO:** Larva collected 19.x.90 while feeding on potted sapling, reared on foliage, pupated 26.x.90, adult emerged 19.xi.90.

Pataeta carbo (Guenee).

The larvae, up to 22 mm in length, are a translucent green, and are covered with short setae. The head capsule and prothoracic shield are a lighter, iridescent green colour. Larvae feed among loosely webbed foliage of young and old growth, and pupate in cocoons bound with silk and frass which are attached to narrow branches. Common (1990) lists larval food-plants as being two Myrtaceae, *Callistemon citrinus* and *E. saligna*.

North Queensland and Darwin records.

Eubenangee Swamp: Larva collected 15.ix.87, reared on foliage, pupated 28.ix.87, adult emerged October 1987. **Gordonvale:** *M. dealbata*. Adult emerged from foliage-feeding larva collected 1.ix.86. **Forrest Beach West:** Larva collected 13.viii.89, reared on foliage, pupated 1.ix.89, adult emerged

21.ix.89. **James Cook University:** *M. diosmatifolia*. Larva collected 20.viii.89, reared on foliage, pupated 18.ix.89, adult emerged 3.x.89. **Berrimah Conservation Commission Nursery:** *M. cajuputi*. Larva collected 28.x.86, reared on foliage, adult emerged 12.xi.86.

South-eastern Queensland records.

Burpengary: Larva collected 20.xi.89, pupated 23.xi.89, adult emerged 16.xii.89. Pupa collected 3.i.90, adult emerged 12.ii.90. Larva collected 22.x.90, pupated 5.xi.90, adult emerged 20.xi.90. **Fitzgibbon:** Larva collected 26.vii.89, pupated 8.viii.89, adult emerged 2.ix.89. **Long Pocket CSIRO:** Pupa collected on shadehouse sapling 5.i.90, adult emerged 19.i.90. 2 larvae collected mid-September, pupated 24.ix.90, adults emerged 10 and 12.x.90. **Palm Beach:** Adult collected 8.iii.90.

Spodoptera litura (Fabricius) (Cluster Caterpillar).

Within Queensland, this polyphagous caterpillar is considered a major pest of crucifers (broccoli, cabbage, cauliflower, turnips, etc) and a minor pest on lettuce and strawberries (Swaine *et al.* 1985) as well as being a minor pest on cotton, *Dubosia* pasture and lawn grasses and tobacco (Swaine and Ironside 1983). Late instar larvae were observed to completely strip at least two 20 cm shadehouse seedlings of *M. quinquenervia* in the course of a day at the ABCL shadehouse in Townsville. **James Cook University:** Larvae reared in the lab began pupating between 31.x.89 and 12.xi.89, 8 adults emerged 12-20.xi.89. **Long Pocket CSIRO:** Larva collected 9.iii.89 on shadehouse sapling, pupated 11.iii.89, adult emerged 23.iii.89. Larva collected 20.x.89, pupated 5.xi.89, adult emerged 22.xi.89.

Spodoptera mauritia (Boisdúval) (Lawn Armyworm).

Larvae are minor pasture and lawn pests in Queensland, (Swain and Ironside 1983) and in the NT on sorghum (Common 1990). A single record of *Hibiscus* (Malvaceae) as a larval food-plant in Norfolk Island is listed by Holloway (1982). **Long Pocket CSIRO:** Adult emerged from larva collected March 1987 while feeding on potted sapling.

Family Thaumetopoeidae

Epicoma protrahens (Lucas).

The larvae, 20-25 mm long, are green to grey in colour, with numerous tufts of hair. Most of the tufts arise from light brown bases, but on the thorax, some tufts have black bases. The large, black spots on the dorsum of abdominal segments, are joined by a pair of thin black lines. In living larvae, these spots on segments 4-8 are at least partially obscured by the bases of hair tufts. Larvae feed gregariously on foliage, and pupate gregariously in a silken web. If disturbed, they drop from the leaf on a silken thread. Common (1990) notes 7 species of *Epicoma* from Australia, with host records mostly from the Myrtaceae (*Calothamus*, *Eucalyptus* and *Leptospermum*). **Burpengary:** 22 larvae collected 28.vi.89, some pupated 6.vii.89, 3 adults

emerged 9.viii.89; 31 larvae collected 16.v.90, 17 adults emerged between 24.ix.90 and 5.xi.90.

Moth Records of Uncertain Host Association

Family Arctiidae

Asura bipars (Walker).

Pottsville: Adult collected 16.i.90.

Schistophleps albida (Walker).

Pease Street Park: Adult collected 17.iii.87.

Noctuidae

Eublemma abrupta (Walker).

Hampson (1910) lists the larval food-plant as *Ficus parasitica* (Moraceae).

Forrest Beach: Pupa collected 20.vii.87, adult emerged 4.viii.87.

Discussion

Although the *Melaleuca*'s are diverse and widespread, the insects associated with them are poorly known. The large, broad-leaved paperbarks belonging to the *Melaleuca leucadendra* complex, are common along Australia's eastern coast, but Jones & Elliot (1986) record only 4 insect species (none of them Noctuoidea moths) as pests of three of these trees; *M. leucadendra*, *M. quinquenervia* and *M. viridiflora*. During our surveys, we have reared over 100 moth species from *M. quinquenervia*, or its close allies (Balciunas *et al.* in press), and 22 of these moth species belong to the superfamily Noctuoidea.

McFarland (1979) in his list of host plants for 280 Australian moth species, presents his rearing records for 67 moth species which would currently be classified under the Noctuoidea. Of these, only three species (all Noctuidae: Nolinae); *Aquila tactalis* (Walker); *Nola bifascialis* (Walker); and an "unidentified large nolid"; were collected by him from *Melaleuca* spp. All three were found on *M. gibbosa* Labill, although McFarland also collected *N. bifascialis*, less frequently, on *M. oraria* J.M. Black, and reared *A. tactalis* on *M. megacephala* F. Muell. in the laboratory.

Aquila tactalis and *Nola* sp. are the only Noctuoidea among the dozen moths listed by Common (1990) in Appendix B (p. 490) as having *Melaleuca* spp. hosts. Thus, the host records for the 21 Noctuoidea species presented in this paper, are apparently all new.

Of our Noctuoidea collected from *M. quinquenervia* and its allies, the Noctuidae was the best represented family, with 11 species, and included our three most abundant species. This is an apparent contrast with *Eucalyptus*, from which Common (1980, p. 289) lists Noctuidae as one of the moth families which "...avoid *Eucalyptus* entirely or nearly so". This statement, under the present taxonomic arrangement which places Nolidae as a subfamily under Noctuidae, has become less appropriate, since this subfamily

includes the notorious gum-leaf skeletonizer, *Uraba lugens* Walker (Campbell 1962).

Members of the Arctiidae and Thaumetopoeidae were scarcely represented in our *M. quinquenervia* collections, and the Notodontidae were completely absent. The absence of notodontids appears to be a major difference from *Eucalyptus*, since Common (1980, p.289) lists this among the ten moth families "...that include substantial numbers of species dependent on living *Eucalyptus* trees".

Our Noctuoidea do not seem to include any well-known "pests" of *M. quinquenervia*, equivalent to *U. lugens* on *Eucalyptus*. This is unfortunate, since a "pest", if host specific, would be an ideal candidate as a biological control agent for *M. quinquenervia*. The polyphagous agricultural pests (*Olene mendosa*, *Spodoptera litura* and *S. mauritia*) found feeding on our shadehouse cultures of *M. quinquenervia* - but interestingly, never in our field collections - will obviously not be considered as candidates. The best noctuid candidates as biological control agents for *M. quinquenervia* appear to be the highly specific, and relatively common *Careades plana* and *Characoma vallata*. We plan to investigate further, the biological control potential of these two noctuid moths.

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References

- BALCIUNAS, J.K. 1990. Australian insects to control melaleuca. *Aquatics* 12: 15-19.
- BALCIUNAS, J.K. and CENTER, T.D. 1991. Biological Control of *Melaleuca quinquenervia*: Prospects and Conflicts. Pp 1-22. In: Center, T.D., Doren, R.F., Hofstetter, R.L., Meyers, R.L., and Whiteaker, L.D. (eds.), *Proceedings of the Symposium on Exotic Pest Plants*, Miami, Florida, 1988. USA National Park Service, Denver.
- BALCIUNAS, J.K., BURROWS, D.W. and PURCELL, M.F. In press. Australian insects for the biological control of the paperbark tree, *Melaleuca quinquenervia*, a serious pest of Florida, USA, wetlands. In: Delfosse, E.S. and Scott, R.R. (eds.), *Proceedings of the 8th International Symposium on Biological Control of Weeds*, 2-7 February 1992, Canterbury, New Zealand. DSIR/CSIRO, Melbourne.
- BLAKE, S.T. 1968. A revision of *Melaleuca leucadendron* and its allies (Myrtaceae). *Contributions of the Queensland Herbarium*, No.1. Queensland Herbarium, Department of Primary Industries, Brisbane. 114 pp.

- CAMPBELL, F.G. 1962. The biology of *Roselia lugens* (Walker), the gum-leaf skeltonizer moth, with particular references to *Eucalyptus camaldulensis* Dehn. (river red gum) forests of the Murray Valley region. *Proceedings of the Linnaean Society of New South Wales* 87: 316-378.
- COMMON, I.F.B. 1970. Lepidoptera (moths and butterflies). Pp 765-866. In: *The Insects of Australia*. Melbourne University Press, Melbourne.
- COMMON, I.F.B. 1980. Some factors responsible for imbalances in the Australian fauna of Lepidoptera. *Journal of the Lepidopterists' Society* 34: 286-294.
- COMMON, I.F.B. 1990. *Moths of Australia*. Melbourne University Press, Melbourne. xxxii + 535 pp.
- COST, N.D. and CRAVER, G.C. 1981. Distribution of melaleuca in south Florida measured from the air. Pp 1-8. In: Geiger, R.K. (ed.), *Proceedings of the Melaleuca Symposium*. Florida Division of Forestry, Tallahassee.
- FROGGATT, W.W. 1923. *Forest insects of Australia*. Government Printer, Sydney. Pp. xlv + 171.
- HABECK, D.H. 1980. Potential for biological control of *Melaleuca*. Pp 125-129. In: Geiger, R.K. (ed.), *Proceedings of Melaleuca Symposium*. Florida Division of Forestry, Tallahassee.
- HAMPSON, G.F. (1910). *Catalogue of the Lepidoptera in the collection of the British Museum*, Vol. X, Phalaenae. British Museum (Natural History), London. 829 pp.
- HOLLIDAY, I. 1989. *A Field guide to Melaleucas*. Hamlyn, Port Melbourne. 254 pp.
- HOLLOWAY, J.D. 1982. Further notes on the Lepidoptera of Norfolk Island, with particular reference to migrant species. *Journal of Natural History* 16: 351-365.
- JONES, D.L. and ELLIOT, W.R. 1986. *Pests, diseases and ailments of Australian plants*. Lothian, Melbourne. 333 pp.
- LANGELAND, K.A. 1990. Controlling *Melaleuca*, trees from hell. *Aquatics* 12: 10-14.
- MCFARLAND, N. 1979. Annotated list of larval foodplant records for 280 species of Australian Moths. Pp 1-72. *Journal of the Lepidopterists' Society* (supplement to Vol. 33).
- NIELSEN, E.S. and COMMON, I.F.B. 1991. Lepidoptera (moths and butterflies). Pp 817-915 In: *The Insects of Australia*. Melbourne University Press, Melbourne.
- OHMART, C.P. and EDWARDS, P.B. 1991. Insect herbivory on *Eucalyptus*. *Annual Review of Entomology* 36: 637-57.
- ROBINSON, G.S. 1975. *Macrolepidoptera of Fiji and Rotuma: a Taxonomic and biogeographic study*. E.W. Classey, Farrington (Great Britain). ccclvii & clxxiii + 12 maps + 362 pp.
- SWAINE, G. and IRONSIDE, D.A. 1983. *Insect pests of field crops in colour*. Queensland Department of Primary Industries Information Series Q183006, Brisbane. Pp unnumbered.
- SWAINE, G., IRONSIDE, D.A. and YARROW, W.H.I. 1985. *Insect pests of fruit and vegetables in colour*. Queensland Department of Primary Industries Information Series Q183021, Brisbane. Pp unnumbered.